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(54) Title: OSMOTIC DEVICE CONTAINING ALPRAZOLAM AND AN ANTIPSYCHOTIC AGENT

(57) Abstract: The present invention provides an osmotic device containing controlled release alprazolam in the core optionally in combination with an anti-psychotic agent, in a rapid release external coat. A wide range of anti-psychotic agents can be used in this device. Particular embodiments of the invention provide osmotic devices having predetermined release profiles. One preferred embodiment of the osmotic device includes an external coat that has been spray coated rather than compression coated onto the device. The device with spray coated external coat is smaller and easier to swallow than the similar device having a compression coated external coat. The device is useful for the treatment of depression, anxiety or psychosis related disorders.

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**OSMOTIC DEVICE CONTAINING ALPRAZOLAM  
AND AN ANTIPSYCHOTIC AGENT**

**FIELD OF THE INVENTION**

This invention pertains to an osmotic device containing alprazolam and an anti-psychotic agent. More particularly, it pertains to an osmotic device tablet that provides a controlled release of alprazolam and an immediate release of an anti-psychotic agent, wherein the tablet is suited for once-daily administration in the treatment of psychological disorders.

**BACKGROUND OF THE INVENTION**

Clinical depression is a disorder characterized by low self-esteem, guilt, self-reproach, introversion, sadness, despair, sleeping disorders, eating disorders or discouragement. Depression generally causes a lower or decrease of a person's function. Anxiety is a disorder characterized by responses to anticipation of unreal or imagined danger and is known to cause increased heart rate, altered respiration rate, sweating, trembling, weakness, or fatigue. Psychosis is a disorder characterized by gross impairment in reality perception as evidenced by delusions, hallucinations, markedly incoherent speech, or disorganized and agitated behavior without apparent awareness on the part of the person of the incomprehensibility of his behavior.

Major depression and anxiety occur concomitantly in more patients than either one alone. When these disorders occur together, they are associated with more severe symptoms, increased impairment of function, a longer chronic course, poorer outcome, and a higher incidence of suicide.

Antidepressants, such as alprazolam, have been tested for the treatment of depression and symptoms of anxiety. Anti-psychotic agents, such as risperidone, are used

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for the treatment of psychosis. On occasion, a person suffering from depression or anxiety and psychosis will be prescribed an antidepressant agent and an anti-psychotic agent. However, mixed results with this type of combination have been reported in the literature. For example, sometimes no therapeutic advantage for the combination is observed and at  
5 other times, the combination therapy results in additional, excessive or previously unobserved side effects.

Alprazolam is commercially available in tablet dosage form from Alphapharm, Chelsea Labs, Geneva Pharmaceuticals, Lederle Laboratories, Mylan Pharmaceuticals, Novopharm, Pharmacia Upjohn, Purepac Pharmaceuticals, Roxane, Watson Laboratories,  
10 and Zenith Goldline. However, those of skill in the art have not been able to develop a combination formulation containing alprazolam and an anti-psychotic drug. Moreover, there has been no suggestion in the art of a combination osmotic device as claimed herein.

Controlled release capsule dosage forms and osmotic device dosage forms are generally known by the skilled artisan to provide different release profiles. Effective  
15 therapy with antidepressants and anxiolytic agents is dependent upon a careful control of the blood plasma levels of these agents, and therefore, upon the release profiles of these agents from their respective dosage forms.

Osmotic devices and other tablet formulations are known for their ability to provide a controlled release of a wide range of drugs. Such osmotic devices and other tablet  
20 formulations are disclosed in U.S. Patent No. 4,014,334 to Theeuwes et al., U.S. Patent No. 4,576,604 to Guittard et al., Argentina Patent No. 234,493, U.S. Patent No. 4,673,405 to Guittard et al., U.S. Patent No. 5,558,879 to Chen et al., U.S. Patent No. 4,810,502 to Ayer et al., U.S. Patent No. 4,801,461 to Hamel et al., U.S. Patent No. 5,681,584 to Savastano et al., US Patent No. 3,845,770, U.S. Patent No. 6,004,582 to Faour et al., and Argentina Patent  
25 No. 199,301, the entire disclosures of which are hereby incorporated by reference.

These references, however, do not disclose osmotic devices that provide the specific plasma profiles or release profiles for alprazolam (APZ) that the present invention provides. Moreover, the prior art does not disclose an osmotic device containing a combination of alprazolam with an anti-psychotic agent, wherein the alprazolam and anti-  
30 psychotic agent are delivered according to specific release profiles. The delivery of the

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drugs according to the pharmacokinetics disclosed herein renders the claimed osmotic device useful for treating a range of psychological disorders.

### SUMMARY OF THE INVENTION

Alprazolam possesses low water solubility and is therefore difficult to formulate  
5 into a controlled release dosage form that provides an approximately complete delivery of the alprazolam over an extended period of time. The present inventors have succeeded in developing an osmotic device dosage form that provides a controlled release of alprazolam over an extended period of time for once-daily administration. Together with an anti-  
10 psychoses and other neurological/psychological/psychiatric disorders.

In one aspect, the present invention provides an osmotic device comprising:

a core comprising a therapeutically effective amount of alprazolam and at least one osmotic agent or osmopolymer; and

a semipermeable membrane surrounding the core and having a passageway there  
15 through;

wherein the core provides a controlled release of APZ, and at least 60% of the APZ is released within 10 hours after exposure of the osmotic device to an aqueous solution.

Another aspect of the present invention provides an osmotic device for the delivery of APZ and an anti-psychotic agent comprising:

20 a core comprising a therapeutically effective amount of alprazolam and at least one osmotic agent or osmopolymer;

a semipermeable membrane surrounding the core and having a passageway there through; and

25 an external coat comprising a therapeutically effective amount of an anti-psychotic agent;

wherein the core provides a controlled release of APZ, and at least 60% of the APZ is released within 10 hours after exposure of the osmotic device to an aqueous solution, and the external coat provides a rapid release of the anti-psychotic agent, and at least 75% of the anti-psychotic agent is released within 1 hour after exposure of the osmotic device  
30 to an aqueous solution.

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In still other preferred embodiments, the external coat is applied by spray coating or compression coating. By spray coating rather than compression coating the external coat, a thinner external coat, and therefore a smaller osmotic device, is formed.

Another aspect of the invention provides a method of treating depression, anxiety  
5 and/or psychosis in a mammal, the method comprising the step of administering an osmotic device which provides a controlled release of APZ from its core and a rapid release of an anti-psychotic agent from an external coat, wherein at least 75% of the anti-psychotic agent is released within about 40 minutes, and at least about 60% of the APZ is released within about 1 hour after administration.

10 In other embodiments, the osmotic device provides: a) a APZ release profile similar to that shown in Figure 1; or b) a APZ plasma profile similar to that shown in Figure 2. In still other embodiments, the release of APZ and/or the anti-psychotic agent has a delayed onset.

Other embodiments include those wherein the anti-psychotic agent is selected from  
15 the group consisting of risperidone, olanzapine, clozapine, sertindole, ziprasidone, quetiapine, sulpiride, pimozide, clothiapine, molindone, loxapine, trifluoperazine, haloperidol, flupenthixol, chlorpromazine, chlorprothixene, clopenthixol, droperidol, perphenazine, fluphenazine, lithium, mesoridazine, spiperone, promazine, prochlorperazine, thioridazine, thiothixene, triflupromazine and raclopride.

20 According to other embodiments, the anti-psychotic agent is administered once daily at a dose of: a) risperidone- 5 to 10 mg per day; b) olanzapine- 5 to 20 mg, 0.25-50 mg, 1-30 mg, or 1-25 mg per day; c) clozapine- 100 to 400 mg, 12.5-900 mg, or 150-450 mg per day; d) sertindole- 15 to 20 mg per day or 0.0001 to 1.0 mg/kg of body weight per day; e) ziprasidone- 80 to 160 mg, 5 to 500 mg or 50 to 100 mg per day; f) quetiapine- 150  
25 to 600 mg or 1.0-40 mg/kg of body weight per day; g) sulpiride- 50 to 100 mg per day; h) pimozide- 2 to 4 mg per day; or i) clothiapine- 40 mg per day.

The osmotic device generally delivers the anti-psychotic agent to the upper GI tract and the alprazolam to the middle to lower GI tract.

Other features, advantages and embodiments of the invention will become apparent  
30 to those skilled in the art by the following description, accompanying examples.

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### BRIEF DESCRIPTION OF THE FIGURES

The following drawings are part of the present specification and are included to further demonstrate certain aspects of the invention. The invention may be better understood by reference to one or more of these drawings in combination with the detailed description of the specific embodiments presented herein.

FIG. 1 depicts an exemplary *in vitro* release profile for APZ from the exemplary formulation of Example 1 for a 0.5 mg strength tablet.

FIG. 2 depicts an exemplary *in vitro* release profile for APZ from the exemplary formulation of Example 1 for a 1.0 mg strength tablet.

FIG. 3 depicts an exemplary *in vitro* release profile for APZ from the exemplary formulation of Example 1 for a 2.0 mg strength tablet.

FIG. 4 depicts an exemplary *in vitro* release profile for APZ from the exemplary formulation of Example 1 for a 3.0 mg strength tablet.

FIG. 5 depicts an exemplary *in vivo* plasma concentration profile for APZ as provided by the exemplary formulation of Example 2.

### DETAILED DESCRIPTION OF THE INVENTION

Alprazolam (APZ) and anti-psychotic agents are readily available from a large number of commercial sources such as SIGMA CHEMICAL Co. and ALDRICH CHEMICAL Co. and a number of pharmaceutical companies. The invention provides for the administration of alprazolam alone or in combination with an anti-psychotic agent, wherein these compounds are in their free base, free acid, racemic, optically pure, diastereomeric and/or pharmaceutically acceptable salt forms.

As used herein, "pharmaceutically acceptable salts" refer to derivatives of the disclosed compounds wherein the therapeutic compound is modified by making acid or base salts thereof. Examples of pharmaceutically acceptable salts include, but are not limited to, mineral or organic acid salts of the APZ or anti-psychotic agent. The pharmaceutically acceptable salts include the conventional non-toxic salts, for example, from non-toxic inorganic or organic acids. For example, such conventional non-toxic salts include those derived from inorganic acids such as hydrochloric, hydrobromic, sulfuric, sulfonic, sulfamic, phosphoric, nitric and the like; and the salts prepared from organic acids such as amino acids, acetic, propionic, succinic, glycolic, stearic, lactic, malic, tartaric, citric, ascorbic, pantoic,

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maleic, hydroxymaleic, phenylacetic, glutamic, benzoic, salicylic, sulfanilic, 2-acetoxybenzoic, fumaric, toluenesulfonic, methanesulfonic, ethane disulfonic, oxalic, isethionic, and the like. Lists of suitable salts are found in *Remington's Pharmaceutical Sciences*, 17th ed., Mack Publishing Company, Easton, PA, 1985, p. 1418, the disclosure of which is hereby incorporated by reference.

The phrase "pharmaceutically acceptable" is employed herein to refer to those compounds, materials, compositions, and/or dosage forms which are, within the scope of sound medical judgment, suitable for use in contact with the tissues of human beings and animals without excessive toxicity, irritation, allergic response, or other problem or complication, commensurate with a reasonable benefit/risk ratio.

FIG. 1 depicts an alprazolam exemplary *in vitro* release profile for a 0.5 mg strength osmotic device prepared according to the procedure of Example 1. This formulation exhibits an 18-hour or greater controlled release of APZ. The APZ release profile of this exemplary formulation is generally described as follows:

Time (h)	Percent Released
0	0
1	17
3	37
6	58
8	70
10	80
12	84
15	90
18	98

FIG. 2 depicts an alprazolam exemplary *in vitro* release profile for a 1.0 mg strength osmotic device prepared according to the procedure of Example 1. This formulation exhibits an 18-hour or greater controlled release of APZ. The APZ release profile of this exemplary formulation is generally described as follows:

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Time (h)	Percent Released
0	0
1	21
3	34
6	53
8	64
10	73
12	80

FIG. 3 depicts an alprazolam exemplary *in vitro* release profile for a 2.0 mg strength osmotic device prepared according to the procedure of Example 1. This formulation exhibits a 22-hour or greater controlled release of APZ. About 80% of the APZ has been released by about 18 hours after administration. The APZ release profile of this exemplary formulation is generally described as follows:

Time (h)	Percent Released
0	0
1	12
3	27
6	44
8	52
10	60
12	69
15	78
18	83

FIG. 4 depicts an alprazolam exemplary *in vitro* release profile for a 3.0 mg strength osmotic device prepared according to the procedure of Example 1. This formulation exhibits a 22-hour or greater controlled release of APZ. About 80% of the APZ has been released by about 18 hours after administration. The APZ release profile of this exemplary formulation is generally described as follows:



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Time (h)	Percent Released
0	0
1	13
3	28
6	44
8	52
10	61
12	67
15	76
18	82

An osmotic device according to the invention will generally provide an alprazolam release profile as follows:

Time (h)	Percent Released
0	0
1	10-20
3	25-40
6	40-60
8	50-70
10	60-80
12	65-85
15	75-90
18	80-100

- 5           The osmotic device of Example 2 was administered to a group of volunteers and the pharmacokinetic and pharmacodynamic parameters determined. FIG. 5 depicts the *in vivo* plasma concentration profile for APZ as provided by the osmotic device made according to example 2. Generally after a single dose, the target  $C_{max}$  for the alprazolam is about 15 ng/ml, or about 0.8-60 ng/ml or about 5-30 ng/ml, with a  $T_{max}$  of about  $11 \pm 4$  hours or about
- 10   7-15 hours. The plasma profile depicted in FIG. 5 can be described as follows:

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Time After Administration (H)	APZ Concentration (ng/ml)	STD (ng/ml)
0	0	0
1	2.8	2
2	8.1	3.2
3	10.5	2.8
4	10.9	3.5
6	12	3.1
8	12.5	2.9
12	12.9	2.1
16	10.6	3.2
20	10	3.1
30	7.8	2.5
40	3.9	2
50	2	1.9

Depending upon the particular combination of ingredients used to prepare the osmotic device, it will generally provide an expected overall alprazolam release profile resembling a pseudo-first order, first-order, pseudo-second order, or second order release profile.

All of the tablet formulations of the invention will provide therapeutically effective levels of alprazolam and an anti-psychotic agent for at least a predetermined period of time. The tablets of the invention will generally provide therapeutically effective blood level concentrations of alprazolam for a period of not less than 18 hours and not more than 30 hours, not less than 20 hours and not more than 28 hours, or not less than 22 hours and not more than 24 hours. The formulations will generally provide therapeutically effective blood level concentrations of the anti-psychotic agent for a period of at least 12 hours and generally up to about 24 hours. This period will vary according to the anti-psychotic agent used, and its half-life in the subject to which it is administered.

The osmotic device of the invention generally includes a core surrounded by a semipermeable membrane which is surrounded by an anti-psychotic agent-containing coat.

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The osmotic device includes an optional inert water soluble coat between the semipermeable membrane and the anti-psychotic agent-containing coat. The osmotic device also includes an optional exterior finish coat external to the anti-psychotic agent-containing coat.

5 The anti-psychotic agent containing coat can be an immediately dissolving coating that dissolves in the buccal cavity or a rapidly dissolving coating that dissolved in the stomach, jejunum or duodenum. The controlled release core generally begins to release alprazolam within about 2 hours after administration.

10 The anti-psychotic agent-containing coat is a rapid release coat that releases all of its anti-psychotic agent within three hours after administration and preferably at least 75% of its anti-psychotic agent within about 40 minutes after administration. Even though the anti-psychotic agent is released rapidly, it will provide a continued therapeutic effect as described above.

15 Those of ordinary skill in the art will appreciate that the particular amounts of alprazolam and anti-psychotic agent used in the osmotic device will vary according to, among other things, the desired pharmacokinetic behavior in a mammal.

The combination of alprazolam and the anti-psychotic agent provides an unexpectedly higher benefit than either agent alone or than the expected additive effect of the two drugs.

20 When a rapidly dissolving or water soluble coat is used in the tablet formulations of the invention, the coat will generally comprise an inert and non-toxic material that is at least partially, and preferably substantially completely, soluble or erodible in an environment of use. The rapidly dissolving coat will be soluble in the buccal cavity and/or upper GI tract, such as the stomach, duodenum, jejunum or upper small intestines. Exemplary materials are disclosed in U.S. Patents No. 4,576,604 and 4,673,405, and the  
25 text Pharmaceutical Dosage Forms: Tablets Volume I, Second Edition. A. Lieberman. ed. 1989, Marcel Dekker, Inc. the relevant disclosures of which are hereby incorporated by reference. In preferred embodiments, the rapidly dissolving coat will be soluble in saliva, gastric juices, or acidic fluids.

30 The long acting controlled release tablet formulations that provide a delayed and sustained release of alprazolam may include an enteric coat that is soluble or erodible in intestinal juices, substantially pH neutral or basic fluids but for the most part insoluble in

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gastric juices or acidic fluids. The enteric coat may be located somewhere within or outside of the semipermeable membrane. A wide variety of other polymeric materials are known to possess these various solubility properties. Such other polymeric materials include, by way of example and without limitation, cellulose acetate phthalate (CAP),  
5 cellulose acetate trimellitate (CAT), poly(vinyl acetate) phthalate (PVAP), hydroxypropyl methylcellulose phthalate (HP), poly(methacrylate ethylacrylate) (1:1) copolymer (MA-EA), poly(methacrylate methylmethacrylate) (1:1) copolymer (MA-MMA), poly(methacrylate methylmethacrylate) (1:2) copolymer, Eudragit L-30-D™ (MA-EA, 1:1), Eudragit™ L-100-55™ (MA-EA, 1:1), hydroxypropyl methylcellulose acetate succinate (HPMCAS),  
10 Coateric™ (PVAP), Aquateric™ (CAP), AQUACOAT™ (HPMCAS) and combinations thereof. The enteric coat can also comprise dissolution aids, stability modifiers, and bioabsorption enhancers.

When the enteric coat is intended to be dissolved, eroded or become detached from the core in the colon, materials such as hydroxypropylcellulose, microcrystalline cellulose  
15 (MCC, Avicel™ from FMC Corp.), poly (ethylene - vinyl acetate) (60:40) copolymer (EVAC from Aldrich Chemical Co.), 2-hydroxyethylmethacrylate (HEMA), MMA, terpolymers of HEMA: MMA:MA synthesized in the presence of N,N'-bis(methacryloyloxyethyloxycarbonylamino) - azobenzene, azopolymers, enteric coated timed release system (Time Clock® from Pharmaceutical Profiles, Ltd., UK) and calcium  
20 pectinate can be used.

A preferred polymeric material for use in the enteric coat involves enteric materials that resist the action of gastric fluid avoiding permeation through the semipermeable wall while one or more of the materials in the core of the tablet are solubilized in the intestinal tract thereby allowing delivery of the alprazolam in the core by osmotic pumping in an  
25 osmotic device to begin. A material that easily adapts to this kind of requirement is a poly(vinylpyrrolidone)-vinyl acetate copolymer, such as the material supplied by BASF under its Kollidon VA64 trademark, mixed with magnesium stearate and other similar excipients. The enteric coat can also comprise povidone, which is supplied by BASF under its Kollidon K 30 trademark, and hydroxypropyl methylcellulose, which is supplied  
30 by Dow under its Methocel E-15 trademark. The materials can be prepared in solutions of having different concentrations of polymer according to the desired solution viscosity. For

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example, a 10% P/V aqueous solution of Kollidon K 30 has a viscosity of about 5.5-8.5 cps at 20° C, and a 2% P/V aqueous solution of Methocel E-15 has a viscosity of about 13-18 cps at 20° C.

The enteric coat can comprise one or more materials that do not dissolve, disintegrate, or change their structural integrity in the stomach and during the period of time that the tablet resides in the stomach. Representative materials that keep their integrity in the stomach can comprise a member selected from the group consisting of (a) keratin, keratin sandarac-tolu, salol (phenyl salicylate), salol beta-naphthylbenzoate and acetotannin, salol with balsam of Peru, salol with tolu, salol with gum mastic, salol and stearic acid, and salol and shellac; (b) a member selected from the group consisting of formalized protein, formalized gelatin, and formalized cross-linked gelatin and exchange resins; (c) a member selected from the group consisting of myristic acid-hydrogenated castor oil-cholesterol, stearic acid-mutton tallow, stearic acid-balsam of tolu, and stearic acid-castor oil; (d) a member selected from the group consisting of shellac, ammoniated shellac, ammoniated shellac-salol, shellac-wool fat, shellac-acetyl alcohol, shellac-stearic acid-balsam of tolu, and shellac n-butyl stearate; (e) a member selected from the group consisting of abietic acid, methyl abictate, benzoin, balsam of tolu, sandarac, mastic with tolu, and mastic with tolu, and mastic with acetyl alcohol; (f) acrylic resins represented by anionic polymers synthesized from methacrylate acid and methacrylic acid methyl ester, copolymeric acrylic resins of methacrylic and methacrylic acid and methacrylic acid alkyl esters, copolymers of alkacrylic acid and alkacrylic acid alkyl esters, acrylic resins such as dimethylaminoethylmethacrylate-butylmethacrylate-methylmethacrylate copolymer of 150,000 molecular weight, methacrylic acid-methylmethacrylate 50:50 coploymer of 135,000 molecular weight, methacrylic acid-methylmethacrylate-30:70-copolymer of 135,000 mol. wt., methacrylic acid-dimethylaminoethyl-methacrylate-ethylacrylate of 750,000 mol. wt., methacrylic acid-methylmethacrylate-ethylacrylate of 1,000,000 mol. wt., and ethylacrylate-methylmethacrylate-ethylacrylate of 550,000 mol. wt; and, (g) an enteric composition comprising a member selected from the group consisting of cellulose acetyl phthalate, cellulose diacetyl phthalate, cellulose triacetyl phthalate, cellulose acetate phthalate, hydroxypropyl methylcellulose phthalate, sodium cellulose acetate phthalate, cellulose ester phthalate, cellulose ether phthalate, methylcellulose phthalate, cellulose

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ester-ether phthalate, hydroxypropyl cellulose phthalate, alkali salts of cellulose acetate phthalate, alkaline earth salts of cellulose acetate phthalate, calcium salt of cellulose acetate phthalate, ammonium salt of hydroxypropyl methylcellulose phthalate, cellulose acetate hexahydrophthalate, hydroxypropyl methylcellulose hexahydrophthalate, polyvinyl  
5 acetate phthalate diethyl phthalate, dibutyl phthalate, dialkyl phthalate wherein the alkyl comprises from 1 to 7 straight and branched alkyl groups, aryl phthalates, and other materials known to one of ordinary skill in the art.

The semipermeable membrane of the osmotic device is formed of a material that is substantially permeable to the passage of fluid from the environment of use to the core and  
10 substantially impermeable to the passage of active agent from the core. Many common materials known by those of ordinary skill in the art are suitable for this purpose. Exemplary materials are cellulose esters, cellulose ethers and cellulose esters-ethers. However, it has been found that a semipermeable membrane consisting essentially of cellulose acetate (CA) and poly(ethylene glycol) (PEG), in particular PEG 400, are  
15 preferred when used in combination with the other materials required in the present osmotic device. This particular combination of CA and PEG provides a semipermeable membrane that gives the osmotic device a well controlled release profile for the active agent in the core and that retains its chemical and physical integrity in the environment of use. The ratio of CA:PEG generally ranges from about 50-99% by weight of CA: about  
20 50-1% by weight of PEG, and preferably about 95% by weight of CA: about 5% by weight of PEG. The ratio can be varied to alter permeability and ultimately the release profile of the osmotic device. Other preferred materials can include a selected member of the group of cellulose acylates such as cellulose acetate, cellulose diacetate, cellulose triacetate and combinations thereof. Suitable polymers include those disclosed in Argentine Patent No.  
25 199,301 and other references cited herein, the disclosures of which are hereby incorporated by reference.

The core of the osmotic device tablet of the present invention will comprise alprazolam, at least one pharmaceutically acceptable excipient and optionally one or more other materials. Generally, the tablet formulations will comprise about 0.1-99.9% by  
30 weight of alprazolam in the uncoated tablet core. Preferred ranges will vary according to the anti-psychotic agent used and the intended use of the osmotic device.

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When the controlled release tablet is an osmotic device, osmotically effective solutes, osmotic agents or osmagents are added. These osmagents can aid in either the suspension or dissolution of the APZ in the core. Exemplary osmagents include organic and inorganic compounds such as salts, acids, bases, chelating agents, sodium chloride, lithium chloride, magnesium chloride, magnesium sulfate, lithium sulfate, potassium chloride, sodium sulfite, calcium bicarbonate, sodium sulfate, calcium sulfate, calcium lactate, d-mannitol, urea, tartaric acid, raffinose, sucrose, alpha-d-lactose monohydrate, glucose, combinations thereof and other similar or equivalent materials which are widely known in the art. Osmagents can also be incorporated to the core of the osmotic device to control the release of APZ therefrom.

The tablets of the invention can also comprise an acidifying agent, alkalizing agent, adsorbent, antioxidant, buffering agent, colorant, flavorant, sweetening agent, tablet antiadherent, tablet binder, tablet and capsule diluent, tablet direct compression excipient, tablet disintegrant, tablet glidant, tablet lubricant, tablet or capsule opaquant and/or tablet polishing agents.

As used herein, the term "adsorbent" is intended to mean an agent capable of holding other molecules onto its surface by physical or chemical (chemisorption) means. Such compounds include, by way of example and without limitation, powdered and activated charcoal and other materials known to one of ordinary skill in the art.

As used herein, the term "antioxidant" is intended to mean an agent which inhibits oxidation and thus is used to prevent the deterioration of preparations by the oxidative process. Such compounds include, by way of example and without limitation, ascorbic acid, ascorbyl palmitate, butylated hydroxyanisole, butylated hydroxytoluene, hypophosphorous acid, monothioglycerol, propyl gallate, sodium ascorbate, sodium bisulfite, sodium formaldehyde sulfoxylate and sodium metabisulfite and other materials known to one of ordinary skill in the art.

As used herein, the term "alkalizing agent" is intended to mean a compound used to provide alkaline medium for product stability. Such compounds include, by way of example and without limitation, ammonia solution, ammonium carbonate, diethanolamine, monoethanolamine, potassium hydroxide, sodium borate, sodium carbonate, sodium

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bicarbonate, sodium hydroxide, triethanolamine, and trolamine and others known to those of ordinary skill in the art.

As used herein, the term "acidifying agent" is intended to mean a compound used to provide an acidic medium for product stability. Such compounds include, by way of example and without limitation, acetic acid, amino acid, citric acid, fumaric acid and other  
5 alpha hydroxy acids, such as hydrochloric acid, ascorbic acid, and nitric acid and others known to those of ordinary skill in the art.

As used herein, the term "buffering agent" is intended to mean a compound used to resist change in pH upon dilution or addition of acid or alkali. Such compounds include, by  
10 way of example and without limitation, potassium metaphosphate, potassium phosphate, monobasic sodium acetate and sodium citrate anhydrous and dihydrate and other materials known to one of ordinary skill in the art.

As used herein, the term "sweetening agent" is intended to mean a compound used to impart sweetness to a preparation. Such compounds include, by way of example and without  
15 limitation, aspartame, dextrose, glycerin, mannitol, saccharin sodium, sorbitol and sucrose and other materials known to one of ordinary skill in the art.

As used herein, the term "tablet antiadherents" is intended to mean agents which prevent the sticking of tablet formulation ingredients to punches and dies in a tableting machine during production. Such compounds include, by way of example and without  
20 limitation, magnesium stearate, talc, calcium stearate, glyceryl behenate, PEG, hydrogenated vegetable oil, mineral oil, stearic acid and other materials known to one of ordinary skill in the art.

As used herein, the term "tablet binders" is intended to mean substances used to cause adhesion of powder particles in table granulations. Such compounds include, by way  
25 of example and without limitation, acacia, alginic acid, carboxymethylcellulose sodium, poly(vinylpyrrolidone), compressible sugar (e.g., NuTab), ethylcellulose, gelatin, liquid glucose, methylcellulose, povidone and pregelatinized starch and other materials known to one of ordinary skill in the art.

When needed, binders may also be included in the tablets. Exemplary binders  
30 include acacia, tragacanth, gelatin, starch, cellulose materials such as methyl cellulose and sodium carboxy methyl cellulose, alginic acids and salts thereof, polyethylene glycol, guar



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gum, polysaccharide, bentonites, sugars, invert sugars, poloxamers (PLURONIC F68, PLURONIC F127), collagen, albumin, gelatin, cellulose in nonaqueous solvents, combinations thereof and the like. Other binders include, for example, polypropylene glycol, polyoxyethylene-polypropylene copolymer, polyethylene ester, polyethylene sorbitan ester, polyethylene oxide, combinations thereof and other materials known to one of ordinary skill in the art.

As used herein, the term "tablet and capsule diluent" or "fillers" is intended to mean inert substances used as fillers to create the desired bulk, flow properties, and compression characteristics in the preparation of tablets and capsules. Such compounds include, by way of example and without limitation, dibasic calcium phosphate, kaolin, lactose, sucrose, mannitol, microcrystalline cellulose, powdered cellulose, precipitated calcium carbonate, sorbitol, and starch and other materials known to one of ordinary skill in the art.

As used herein, the term "tablet direct compression excipient" is intended to mean a compound used in direct compression tablet formulations. Such compounds include, by way of example and without limitation, dibasic calcium phosphate (e.g., Datab) and other materials known to one of ordinary skill in the art.

As used herein, the term "tablet glidant" is intended to mean agents used in tablet and capsule formulations to reduce friction during tablet compression. Such compounds include, by way of example and without limitation, colloidal silica, cornstarch, talc, calcium silicate, magnesium silicate, colloidal silicon, silicon hydrogel and other materials known to one of ordinary skill in the art.

As used herein, the term "tablet lubricant" is intended to mean substances used in tablet formulations to reduce friction during tablet compression. Such compounds include, by way of example and without limitation, calcium stearate, magnesium stearate, mineral oil, stearic acid, and zinc stearate and other materials known to one of ordinary skill in the art.

As used herein, the term "tablet/capsule opaquant" is intended to mean a compound used to render a capsule or a tablet coating opaque. May be used alone or in combination with a colorant. Such compounds include, by way of example and without limitation, titanium dioxide and other materials known to one of ordinary skill in the art.

As used herein, the term "tablet polishing agent" is intended to mean a compound used to impart an attractive sheen to coated tablets. Such compounds include, by way of

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example and without limitation, carnauba wax, and white wax and other materials known to one of ordinary skill in the art.

As used herein, the term "tablet disintegrant" is intended to mean a compound used in solid dosage forms to promote the disruption of the solid mass into smaller particles which are more readily dispersed or dissolved. Exemplary disintegrants include, by way of example and without limitation, starches such as corn starch, potato starch, pre-gelatinized and modified starches thereof, sweeteners, clays, such as bentonite, microcrystalline cellulose (e.g., Avicel), carboxymethylcellulose calcium, cellulose polyacrilin potassium (e.g., Amberlite), alginates, sodium starch glycolate, gums such as agar, guar, locust bean, karaya, pectin, tragacanth and other materials known to one of ordinary skill in the art.

As used herein, the term "colorant" is intended to mean a compound used to impart color to solid (e.g., tablets) pharmaceutical preparations. Such compounds include, by way of example and without limitation, FD&C Red No. 3, FD&C Red No. 20, FD&C Yellow No. 6, FD&C Blue No. 2, D&C Green No. 5, D&C Orange No. 5, D&C Red No. 8, caramel, and ferric oxide, red, other F.D. & C. dyes and natural coloring agents such as grape skin extract, beet red powder, beta-carotene, annato, carmine, turmeric, paprika, and other materials known to one of ordinary skill in the art. The amount of coloring agent used will vary as desired.

As used herein, the term "flavorant" is intended to mean a compound used to impart a pleasant flavor and often odor to a pharmaceutical preparation. Exemplary flavoring agents or flavorants include synthetic flavor oils and flavoring aromatics and/or natural oils, extracts from plants, leaves, flowers, fruits and so forth and combinations thereof. These may also include cinnamon oil, oil of wintergreen, peppermint oils, clove oil, bay oil, anise oil, eucalyptus, thyme oil, cedar leave oil, oil of nutmeg, oil of sage, oil of bitter almonds and cassia oil. Other useful flavors include vanilla, citrus oil, including lemon, orange, grape, lime and grapefruit, and fruit essences, including apple, pear, peach, strawberry, raspberry, cherry, plum, pineapple, apricot and so forth. Flavors that have been found to be particularly useful include commercially available orange, grape, cherry and bubble gum flavors and mixtures thereof. The amount of flavoring may depend on a number of factors, including the organoleptic effect desired. Flavors will be present in any amount as desired by those of

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ordinary skill in the art. Particularly preferred flavors are the grape and cherry flavors and citrus flavors such as orange.

The present tablets can also employ one or more commonly known surface active agents or cosolvents that improve wetting or disintegration of the tablet core or layers.

- 5 Plasticizers can also be included in the tablets to modify the properties and characteristics of the polymers used in the coats or core of the tablets. As used herein, the term "plasticizer" includes all compounds capable of plasticizing or softening a polymer or binder used in invention. The plasticizer should be able to lower the melting temperature or glass transition temperature (softening point temperature) of the polymer or binder.
- 10 Plasticizers, such as low molecular weight PEG, generally broaden the average molecular weight of a polymer in which they are included thereby lowering its glass transition temperature or softening point. Plasticizers also generally reduce the viscosity of a polymer. It is possible the plasticizer will impart some particularly advantageous physical properties to the osmotic device of the invention.
- 15 Plasticizers useful in the invention can include, by way of example and without limitation, low molecular weight polymers, oligomers, copolymers, oils, small organic molecules, low molecular weight polyols having aliphatic hydroxyls, ester-type plasticizers, glycol ethers, poly(propylene glycol), multi-block polymers, single block polymers, low molecular weight poly(ethylene glycol), citrate ester-type plasticizers, triacetin, propylene glycol and glycerin. Such plasticizers can also include ethylene glycol, 1,2-butylene glycol, 2,3-butylene glycol, styrene glycol, diethylene glycol, triethylene glycol, tetraethylene glycol and other poly(ethylene glycol) compounds, monopropylene glycol monoisopropyl ether, propylene glycol monoethyl ether, ethylene glycol monoethyl ether, diethylene glycol monoethyl ether, sorbitol lactate, ethyl lactate, butyl lactate, ethyl glycolate, dibutylsebacate, 25 acetyltributylcitrate, triethyl citrate, acetyl triethyl citrate, tributyl citrate and allyl glycolate. All such plasticizers are commercially available from sources such as Aldrich or Sigma Chemical Co. It is also contemplated and within the scope of the invention, that a combination of plasticizers may be used in the present formulation. The PEG based plasticizers are available commercially or can be made by a variety of methods, such as 30 disclosed in *Poly(ethylene glycol) Chemistry: Biotechnical and Biomedical Applications*

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(J.M. Harris, Ed.; Plenum Press, NY) the disclosure of which is hereby incorporated by reference.

The tablets of the invention can also include oils, for example, fixed oils, such as peanut oil, sesame oil, cottonseed oil, corn oil and olive oil; fatty acids, such as oleic acid, stearic acid and isotearic acid; and fatty acid esters, such as ethyl oleate, isopropyl myristate, fatty acid glycerides and acetylated fatty acid glycerides. It can also be mixed with alcohols, such as ethanol, isopropanol, hexadecyl alcohol, glycerol and propylene glycol; with glycerol ketals, such as 2,2-dimethyl-1,3-dioxolane-4-methanol; with ethers, such as poly(ethyleneglycol) 450, with petroleum hydrocarbons, such as mineral oil and petrolatum; with water, or with mixtures thereof; with or without the addition of a pharmaceutically suitable surfactant, suspending agent or emulsifying agent.

Soaps and synthetic detergents may be employed as surfactants and as vehicles for detergent compositions. Suitable soaps include fatty acid alkali metal, ammonium, and triethanolamine salts. Suitable detergents include cationic detergents, for example, dimethyl dialkyl ammonium halides, alkyl pyridinium halides, and alkylamine acetates; anionic detergents, for example, alkyl, aryl and olefin sulfonates, alkyl, olefin, ether and monoglyceride sulfates, and sulfosuccinates; nonionic detergents, for example, fatty amine oxides, fatty acid alkanolamides, and poly(oxyethylene)-*block*-poly(oxypropylene) copolymers; and amphoteric detergents, for example, alkyl  $\beta$ -aminopropionates and 2-alkylimidazoline quaternary ammonium salts; and mixtures thereof.

Various other components, not otherwise listed above, can be added to the present formulation for optimization of a desired active agent release profile including, by way of example and without limitation, glycerylmonostearate, nylon, cellulose acetate butyrate, d, l-poly(lactic acid), 1,6 - hexanediamine, diethylenetriamine, starches, derivatized starches, acetylated monoglycerides, gelatin coacervates, poly(styrene - maleic acid) copolymer, glycowax, castor wax, stearyl alcohol, glycerol palmitostearate, poly(ethylene), poly(vinyl acetate), poly(vinyl chloride), 1,3 - butylene-glycoldimethacrylate, ethyleneglycol-dimethacrylate and methacrylate hydrogels.

It should be understood, that compounds used in the art of pharmaceutical formulation generally serve a variety of functions or purposes. Thus, if a compound named herein is mentioned only once or is used to define more than one term herein, its purpose or

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function should not be construed as being limited solely to that named purpose(s) or function(s).

By the term "effective amount", it is understood that, with respect to, for example, pharmaceuticals, a therapeutically effective amount is contemplated. A therapeutically  
5 effective amount is the amount or quantity of alprazolam which is sufficient to elicit the required or desired therapeutic response, or in other words, the amount which is sufficient to elicit an appreciable biological response when administered to a patient.

The tablets of the invention can assume any shape or form known in the art of pharmaceutical sciences. The device of the invention can be a pill, sphere, tablet, bar,  
10 plate, paraboloid of revolution, ellipsoid of revolution or the like. The tablets can also include surface markings, cuttings, grooves, letters and/or numerals for the purposes of decoration, identification and/or other purposes.

The tablets of the invention can be prepared according to the methods disclosed herein or those well known in the art, more specifically according to the methods disclosed  
15 in the disclosure incorporated herein by reference. For example, according to one manufacturing technique, alprazolam and excipients that comprise the core are mixed in solid, semisolid or gelatinous form, then moistened and sieved through a specified screen to obtain uncoated cores. The uncoated cores are then dried in a dryer and compressed, for example, by punching. The compressed and uncoated cores are then covered with a  
20 semipermeable membrane. Subsequently, the semipermeable membrane surrounding the core should be perforated with, for example, laser equipment. Finally, an external coat containing the anti-psychotic agent is applied to the semipermeable membrane.

The external coat can be applied as a compression coating, but it is preferably applied as a sprayed coating. The sprayed coating is thinner and lighter than the  
25 compression coating, and an osmotic device including the sprayed on external coating is, therefore, smaller than a similar osmotic device having a compression coat. A smaller size osmotic device generally results in increased patient compliance in taking the osmotic device and is therefore advantageous.

The tablets of the invention can be coated with a finish coat as is commonly done  
30 in the art to provide the desired shine, color, taste or other aesthetic characteristics.

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Materials suitable for preparing the finish coat are well known in the art and found in the disclosures of many of the references cited and incorporated by reference herein.

Generally, the terms "tablet" and "osmotic device" are used interchangeably herein in describing the invention. The osmotic device of the invention comprises at least one  
5 passageway (pore, hole, or aperture) that communicates the exterior of the semipermeable wall with the core of the device. The passageway can be formed according to any of the known methods of forming passageways in a semipermeable membrane. Such methods include, for example, 1) drilling a hole through the semipermeable membrane with a bit or laser; 2) including a water soluble material within the composition that forms the  
10 semipermeable membrane such that a pore forms when the osmotic device is in an aqueous environment of use; 3) punching a hole through the semipermeable membrane; or 4) employing a tablet punch having a pin to punch a hole through the semipermeable lamina. The passageway can pass through the semipermeable wall and one or more of any other lamina coated onto the semipermeable membrane or between the semipermeable  
15 membrane and the core. The passageway(s) can be shaped as desired. In some embodiments, the passageway is laser drilled and is shaped as an oval, ellipse, slot, slit, cross or circle.

Methods of forming passageways in semipermeable membranes of osmotic devices are disclosed in U.S. Patents No. 4,088,864 to Theeuwes et al., No. 4,016,880 to Theeuwes  
20 et al., No. 3,916,899 to Theeuwes et al., No. 4,285,987 to Ayer et al., No. 4,783,337 to Wong et al., No. 5,558,879 to Chen et al., No. 4,801,461 to Hamel et al., and No. 3,845,770 to Theeuwes et al., the disclosures of which are hereby incorporated by reference.

The preformed passageway, e.g., one made by mechanical means, is formed after  
25 the semipermeable membrane is applied to the core. It can be formed either before or after the inert water soluble coat and/or drug-containing external coat is applied to the semipermeable membrane.

The advantages of the present system over known systems for administering alprazolam in combination with an anti-psychotic agent include improved therapeutic  
30 benefit, simplified manufacturing, and/or increased patient compliance. Moreover, the

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present formulation will provide an enhanced therapeutic effect when compared to the administration of alprazolam or the anti-psychotic agent alone.

By administration of the alprazolam in a controlled release fashion and the anti-psychotic agent in a rapid release fashion, the osmotic device unexpectedly provides  
5 an improved pharmacological profile including reduced side effects, lower drug requirement and/or enhanced therapeutic benefit as compared to other known methods or dosage forms.

The osmotic device of the invention is useful for treating a variety of psychological disorders. The osmotic device can be used to treat psychotic conditions and mild anxiety  
10 with the atypical anti-psychotics without the concomitant weight gain typically observed with such treatment, conferring a marked and unexpected benefit on the patient.

The present invention is particularly suited for use in the treatment of bipolar disorders, mania (mixed state), schizoaffective disorders characterized by the occurrence of a depressive episode during the period of illness, and depression with psychotic  
15 features. Such disorders may often be resistant to treatment with an anti-psychotic alone.

The present invention is also useful for the treatment of premenstrual syndrome (PMS) and anorexia nervosa. Furthermore, the present invention is useful for the treatment of the aggression/violence that may be associated with certain disorders. These disorders include, but are not limited to, mania, schizophrenia, schizoaffective disorders, substance  
20 abuse, head injury, and mental retardation.

Psychotic conditions to be treated by the present osmotic device include, for example, schizophrenia, schizophreniform diseases, acute mania, schizoaffective disorders, and depression with psychotic features. The titles given these conditions represent multiple disease states. The following list illustrates a number of these disease  
25 states, many of which are classified in the Diagnostic and Statistical Manual of Mental Disorders, 4th Edition, published by the American Psychiatric Association (DSM). The DSM code numbers for these disease states are supplied below, when available, for the convenience of the reader: Paranoid Type Schizophrenia 295.30; Disorganized Type Schizophrenia 295.10; Catatonic Type Schizophrenia 295.20; Undifferentiated Type  
30 Schizophrenia 295.90; Residual Type Schizophrenia 295.60; Schizophreniform Disorder

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295.40; Schizoaffective Disorder 295.70; Schizoaffective Disorder of the Depressive Type; and Major Depressive Disorder with Psychotic Features 296.24, 296.34.

Psychoses are often associated with other diseases and conditions, or caused by such other conditions. For example, they are associated with neurological conditions, endocrine conditions, metabolic conditions, fluid or electrolyte imbalances, hepatic or renal diseases, and autoimmune disorders with central nervous system involvement. Psychoses may also be associated with use or abuse of certain substances. These substances include, but are not limited to cocaine, methylphenidate, dexamethasone, amphetamine and related substances, cannabis, hallucinogens, inhalants, opioids, phencyclidine, sedatives, hypnotics and anxiolytics. Psychotic disorders may also occur in association with withdrawal from certain substances. These substances include, but are not limited to, sedatives, hypnotics and anxiolytics. The embodiments of the present invention are useful for treatment of psychotic conditions associated with any of these conditions.

The above-mentioned diseases and disorders are treated in a mammal by administering one or more of the osmotic devices described herein. Each osmotic device is designed for once-daily administration. A patient receiving the osmotic devices will generally be administered one osmotic-device daily for a period of days, week, months or years to be determined by the prescribing physician. Generally, the period is at least one week.

The following examples should not be considered exhaustive, but merely illustrative of only a few of the many embodiments contemplated by the present invention. The methods described herein can be followed to prepare osmotic devices according to the invention.

#### EXAMPLE 1

A large scale batch of alprazolam (1 mg strength) tablets was prepared by mixing 0.950 g of Alprazolam, 7.00 g of hydroxypropyl methylcellulose 2208, 114.00 g of sodium chloride, 58.45 g of microcrystalline cellulose, 30.0 g of povidone, 80.00 g of polyethylene oxide (molecular weight of about 300,000). The mixture was wet with a blend of 110.00 ml of alcohol 96° and 1.40 g of Polysorbate 20. The blend was granulated and dried at 40 – 50°C for 3 hours; then, it was screened and mixed with 3.80 g of colloidal silicon dioxide. The blend was mixed to homogeneity and 4.40 g of magnesium stearate was added as



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lubricant. The final blend was tabletted using biconcaves, 9.00-mm diameter punches. Cores weight: 300.0 mg. Hardness from 8 to 12 kp.

A first composition to cover the cores was prepared as follows: 36.90 g of cellulose acetate and 1.95 g of polyethylene glycol 400 in a mixture of 493 ml of methylene chloride and 122 ml of methyl alcohol. This polymer mixture was sprayed onto the tablets in a conventional pan coater to obtain film-coated tablets which membrane coating weighed 38.9 mg approximately. A 0.75-mm hole was drilled through the coating in one face of the tablet.

The third composition was prepared by mixing 3.00 g of copolyvidone, 3.48 g of titanium dioxide, 8.51 g of talc and 7.00 mg of Aluminum Lake Brilliant Blue in isopropyl alcohol. This polymer mixture was sprayed onto the tablets in a conventional pan coater to obtain film-coated tablets which membrane coating weighed 15 mg approximately.

The rapid release external coating was prepared by mixing 0.05 g of alprazolam, 442.05 g of microcrystalline cellulose, 31.40 g of povidone, 18.20 g of crospovidone and 3.30 g of colloidal silicon dioxide. The mixture was blended to homogeneity; then, 5.00 g of magnesium stearate was added as lubricant. This blend was applied over the film-coated tablets by compression using biconcaves, 14.0-mm diameter punches. Coating weight: 500 mg. Hardness from 8 to 14 kp.

The final coating was prepared by mixing 12.1 g of hydroxypropyl methylcellulose 2910, 3.5 g of polyethylene glycol 6000 and 4.40 g of titanium dioxide in a mixture of methylene chloride-alcohol 96° 70:30 v/v (volume/volume). This polymer mixture was sprayed onto the tablets in a conventional pan coater to obtain film-coated tablets which membrane coating weighed 20 mg approximately.

Tablets made according to the above procedure will generally have the following composition.

Component x 1 tablet	0.5 mg	1.0 mg	2.0 mg
<i>CORE</i>			
Alprazolam	0.475 mg	0.950 mg	1.900 mg
Polysorbate 20	0.700 mg	1.400 mg	2.800 mg
Microcrystalline Cellulose	29.225 mg	58.450 mg	116.900 mg
Sodium Chloride	57.000 mg	114.000 mg	228.000 mg
Povidone	15.000 mg	30.000 mg	60.000 mg

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Polyethylene Oxide	40.000 mg	80.000 mg	160.000 mg
Hydroxypropyl methylcellulose 2208	3.500 mg	7.000 mg	14.000 mg
Colloidal Silicon Dioxide	1.900 mg	3.800 mg	7.600 mg
Magnesium Stearate	2.200 mg	4.400 mg	8.800 mg

*COATING A*

Cellulose Acetate	22.000 mg	36.900 mg	51.900 mg
Polyethylene Glycol 400	1.160 mg	1.950 mg	2.740 mg

*COATING B*

Copolyvidone	2.000 mg	3.000 mg	4.400 mg
Titanium Dioxide	1.650 mg	3.480 mg	5.100 mg
Talc	6.345 mg	8.513 mg	12.490 mg
Aluminium Lake Brilliant Blue	0.005 mg	0.007 mg	0.010 mg

*COATING C*

Alprazolam	0.025 mg	0.050 mg	0.100 mg
Microcrystalline Cellulose	309.375 mg	442.050 mg	618.900 mg
Povidone	22.000 mg	31.400 mg	43.900 mg
Crospovidone	12.800 mg	18.200 mg	25.500 mg
Colloidal Silicon Dioxide	2.300 mg	3.300 mg	4.600 mg
Magnesium Stearate	3.500 mg	5.000 mg	7.000 mg

*COATING D*

Hydroxypropylmethylcellulose 2910	9.100 mg	12.100 mg	15.100 mg
Polyethylene Glycol 6000	2.590 mg	3.500 mg	4.400 mg
Titanium Dioxide	3.310 mg	4.400 mg	5.500 mg

**EXAMPLE 2**

A large scale batch of Alprazolam (2 mg strength) and Risperidone (5 mg strength) tablets was prepared by mixing 2.00 g of Alprazolam, 14.00 g of Hydroxypropyl methylcellulose 2208, 228.00 g of Sodium Chloride, 116.80 g of Microcrystalline Cellulose, 60.0 g of Povidone, 160.00 g of Polyethylene Oxide (molecular weight of about 300,000). The mixture was wet with a blend of 110.00 ml of alcohol 96° and 2.80 g of Polysorbate 20. The blend was granulated and dried at 40 – 50°C for 3 hours; then, it was screened and mixed with 7.60 g of Colloidal Silicon Dioxide. The blend was mixed to homogenize and 8.80 g of Magnesium Stearate was added as lubricant. The final blend was tabletted using biconcaves, 10.50-mm diameter punches. Cores weight: 600.0 mg. Hardness from 8 to 12 kp.

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A first composition to cover the cores was prepared as follows: 51.90 g of Cellulose Acetate and 2.74 g of Polyethylene Glycol 400 in a mixture of 493 ml of Methylene Chloride and 122 ml of Methyl Alcohol. This polymer mixture was sprayed onto the tablets in a conventional pan coater to obtain film-coated tablets which membrane coating weighed 54.6 mg approximately. A 0.75-mm hole was drilled through the coating in one face of the tablet.

The third composition was prepared by mixing 4.40 g of Copolyvidone, 5.10 g of Titanium Dioxide, 12.49 g of Talc and 10.00 mg of Aluminum Lake Brilliant Blue in Isopropyl Alcohol. This polymer mixture was sprayed onto the tablets in a conventional pan coater to obtain film-coated tablets which membrane coating weighed 22 mg approximately.

The rapid release external coating was prepared by mixing 5.00 g of Risperidone, 594.36 g of Microcrystalline Cellulose, 50.30 g of Povidone, 32.25 g of Crospovidone and 4.72 g of Colloidal Silicon Dioxide. The mixture was blended to homogenize; then, 13.37 g of Magnesium Stearate was added as lubricant. This blend was applied over the film-coated tablets by compression using biconcaves, 14.0-mm diameter punches. Coating weight: 700 mg. Hardness from 8 to 15 kp.

The final coating was prepared by mixing 27.27 g of Hydroxypropyl methylcellulose 2910, 7.77 g of Polyethylene Glycol 6000, 9.96 g of Titanium Dioxide in a mixture of Methylene Chloride-Alcohol 96° 70:30 v/v (volume/volume). This polymer mixture was sprayed onto the tablets in a conventional pan coater to obtain film-coated tablets which membrane coating weighed 30 mg approximately.

Tablets made according to the above-described procedure generally have a formulation as follows:

**CORE**

Alprazolam	2.000 mg
Polysorbate 20	2.800 mg
Microcrystalline Cellulose	116.800 mg
Sodium Chloride	228.000 mg
Povidone	60.000 mg
Polyethylene Oxide	160.000 mg
Hydroxypropyl methylcellulose 2208	14.000 mg
Colloidal Silicon Dioxide	7.600 mg
Magnesium Stearate	8.800 mg

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**CORE****COATING A**

Cellulose Acetate	51.900 mg
Polyethylene Glycol 400	2.740 mg

**COATING B**

Copolyvidone	4.400 mg
Titanium Dioxide	5.100 mg
Talc	12.490 mg
Aluminium Lake brilliant Blue	0.010 mg

**COATING D**

Risperidone	5.000 mg
Microcrystalline Cellulose	597.360 mg
Povidone	50.300 mg
Crospovidone	32.250 mg
Colloidal Silicon Dioxide	4.720 mg
Magnesium Stearate	13.370 mg

**COATING E**

Hydroxypropylmethylcellulose 2910	18.180 mg
Polyethylene Glycol 6000	5.180 mg
Titanium Dioxide	6.640 mg

**EXAMPLE 3**

The procedure of Example 2 is used to prepare osmotic devices having the following general composition.

**Core**

Alprazolam		0.5-5.0 mg
Polysorbate 20 (Wetting Agent)		0.1-5.0 mg
Microcrystalline Cellulose (Filler)		50-200 mg
Sodium Chloride (Osmagent)		150-300 mg
Povidone (binder)		10-100 mg
Polyethylene Oxide (Osmopolymer)		130-190 mg
Hydroxypropyl methylcellulose	2208	10-200 mg
(Viscosity increasing agent)		
Colloidal Silicon Dioxide (Glidant)		2.5-10 mg
Magnesium Stearate (Lubricant)		5-10 mg

**Semipermeable Coat**

Cellulose Acetate (Cellulose ester)	20-75 mg
Polyethylene Glycol 400 (Plasticizer)	1-4 mg

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***First Inert Water Soluble Coat***

Copolyvidone (Water soluble polymer)	2-10 mg
Titanium Dioxide (Opaquant)	1-20 mg
Talc (Filler, Opaquant)	0-18 mg
Aluminum Lake Brilliant Blue (Colorant)	0.001-0.02 mg

***Anti-psychotic Agent-containing Coat***

Risperidone (Anti-psychotic agent)	2.5-7.5 mg
Microcrystalline Cellulose (filler)	300-700 mg
Povidone (Binder)	10-80 mg
Crospovidone (Disintegrant)	25-40 mg
Colloidal Silicon Dioxide (Glidant)	1-7 mg
Magnesium Stearate (Lubricant)	4-10.5 mg

***Finish Coat (optional)***

Hydroxypropyl methylcellulose 2910 (Water soluble polymer)	12-25 mg
Polyethylene Glycol 6000 (Plasticizer)	2-7 mg
Titanium Dioxide (Opaquant)	3.5-10 mg

The above is a detailed description of particular embodiments of the invention. It is recognized that departures from the disclosed embodiments may be made within the scope of the invention and that obvious modifications will occur to a person skilled in the art. Those of skill in the art should, in light of the present disclosure, appreciate that many changes can be made in the specific embodiments which are disclosed herein and still obtain a like or similar result without departing from the spirit and scope of the invention. All of the embodiments disclosed and claimed herein can be made and executed without undue experimentation in light of the present disclosure.

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## CLAIMS

We claim:

1. An osmotic device for the delivery of APZ and an anti-psychotic agent comprising:  
a core comprising a therapeutically effective amount of alprazolam and at least one  
5 osmotic agent or osmopolymer;  
a semipermeable membrane surrounding the core and having a passageway there  
through; and  
an external coat comprising a therapeutically effective amount of an anti-psychotic  
agent;  
10 wherein the core provides a controlled release of APZ, and at least 60% of the APZ  
is released within 10 hours after exposure of the osmotic device to an aqueous solution,  
and the external coat provides a rapid release of the anti-psychotic agent, and at least 75%  
of the anti-psychotic agent is released within 1 hour after exposure of the osmotic device  
to an aqueous solution.
- 15 2. The osmotic device of claim 1, wherein the external coat is applied by spraying a  
composition onto the semipermeable membrane.
3. The osmotic device of claim 1, wherein the external coat is compressed about and  
surrounds the semipermeable membrane.
4. The osmotic device of claim 1, wherein at least 75% of the anti-psychotic agent is  
20 released within about 40 minutes, and at least about 60% of the alprazolam is  
released within about 12 hours after administration.
5. The osmotic device of claim 1, wherein the release of at least one of the alprazolam  
and the anti-psychotic agent has a delayed onset.
6. The osmotic device of claim 1, wherein the anti-psychotic agent is selected from  
25 the group consisting of risperidone, olanzapine, clozapine, sertindole, ziprasidone,  
quetiapine, sulpiride, pimozide, clothiapine, molindone, loxapine, trifluoperazine,  
haloperidol, flupenthixol, chlorpromazine, chlorprothixene, clopenthixol,  
droperidol, perphenazine, fluphenazine, lithium, mesoridazine, spiperone,  
promazine, prochlorperazine, thioridazine, thiothixene, triflupromazine and  
30 raclopride.

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7. The osmotic device of claim 6, wherein the alprazolam is administered once daily at a dose of 2-7 mg and the anti-psychotic agent is administered once daily at a dose of: a) risperidone- 5 to 10 mg per day; b) olanzapine- 5 to 20 mg, 0.25-50 mg, 1-30 mg, or 1-25 mg per day; c) clozapine- 100 to 400 mg, 12.5-900 mg, or 150-450 mg per day; d) sertindole- 15 to 20 mg per day or 0.0001 to 1.0 mg/kg of body weight per day; e) ziprasidone- 80 to 160 mg, 5 to 500 mg or 50 to 100 mg per day; f) quetiapine- 150 to 600 mg or 1.0-40 mg/kg of body weight per day; g) sulpiride- 50 to 100 mg per day; h) pimozide- 2 to 4 mg per day; or i) clothiapine- 40 mg per day.
8. The osmotic device of claim 1, wherein the osmotic device delivers the anti-psychotic agent to the upper GI tract and the alprazolam to the middle to lower GI tract.
9. The osmotic device of claim 1, wherein the osmotic device provides an alprazolam  $C_{max}$  of about 0.8-60 ng/ml of plasma in a mammal.
10. The osmotic device of claim 9, wherein the osmotic device provides an alprazolam  $T_{max}$  at about 7-15 hours.
11. The osmotic device of claim 1, wherein the osmotic device provides an alprazolam dissolution profile as follows:

Time (h)	Percent Released
0	0
1	10-20
3	25-40
6	40-60
8	50-70
10	60-80
12	65-85
15	75-90
18	80-100

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12. The osmotic device of claim 1, wherein the osmotic device provides a single-dose alprazolam plasma concentration profile in a mammal as follows:

Time After Administration (H)	APZ Concentration (ng/ml)	STD (ng/ml)
0	0	0
1	2.8	2
2	8.1	3.2
3	10.5	2.8
4	10.9	3.5
6	12	3.1
8	12.5	2.9
12	12.9	2.1
16	10.6	3.2
20	10	3.1
30	7.8	2.5
40	3.9	2
50	2	1.9

5 13. The osmotic device of claim 1, wherein the osmotic device further comprises a first water soluble coat between the semipermeable membrane and the external coat.

14. The osmotic device of claim 13 comprising the following ingredients in the approximate amounts indicated:

***Core***

Alprazolam	0.5-5.0 mg
Wetting Agent	0.1-5.0 mg
Filler	50-200 mg
Osmagent	150-300 mg
binder	10-100 mg
Osmopolymer	130-190 mg
Viscosity increasing agent	10-200 mg

***Semipermeable Coat***

Cellulose ester	20-75 mg
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Plasticizer 1-4 mg

***First Inert Water Soluble Coat***

Water soluble polymer 2-10 mg

Opaquant 1-20 mg

Filler 0-18 mg

***Anti-psychotic Agent-containing Coat***

Anti-psychotic agent 2.5-7.5 mg

Filler 300-700 mg

Binder 10-80 mg

Disintegrant 25-40 mg

15. The osmotic device of claim 14, wherein the anti-psychotic agent is selected from the group consisting of risperidone, olanzapine, clozapine, sertindole, ziprasidone, quetiapine, sulpiride, pimozone, clothiapine, molindone, loxapine, trifluoperazine, haloperidol, flupenthixol, chlorpromazine, chlorprothixene, clopenthixol, droperidol, perphenazine, fluphenazine, lithium, mesoridazine, spiperone, promazine, prochlorperazine, thioridazine, thiothixene, triflupromazine and raclopride.
16. The osmotic device of claim 15, wherein the alprazolam is administered once daily at a dose of 2-8 mg and the anti-psychotic agent is administered once daily at a dose of: a) risperidone- 5 to 10 mg per day; b) olanzapine- 5 to 20 mg, 0.25-50 mg, 1-30 mg, or 1-25 mg per day; c) clozapine- 100 to 400 mg, 12.5-900 mg, or 150-450 mg per day; d) sertindole- 15 to 20 mg per day or 0.0001 to 1.0 mg/kg of body weight per day; e) ziprasidone- 80 to 160 mg, 5 to 500 mg or 50 to 100 mg per day; f) quetiapine- 150 to 600 mg or 1.0-40 mg/kg of body weight per day; g) sulpiride- 50 to 100 mg per day; h) pimozone- 2 to 4 mg per day; or i) clothiapine- 40 mg per day.
17. The osmotic device of claim 14, wherein the osmotic device provides an alprazolam dissolution profile as follows:

Time (h)	Percent Released
0	0
1	10-20

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Time (h)	Percent Released
3	25-40
6	40-60
8	50-70
10	60-80
12	65-85
15	75-90
18	80-100

18. A method of treating depression, anxiety and/or psychosis in a mammal, the method comprising the step of administering an osmotic device according to any one of claims 1-17.

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FIG. 1

**Dissolution Profile for 0.5 mg tablets of  
Alprazolam**

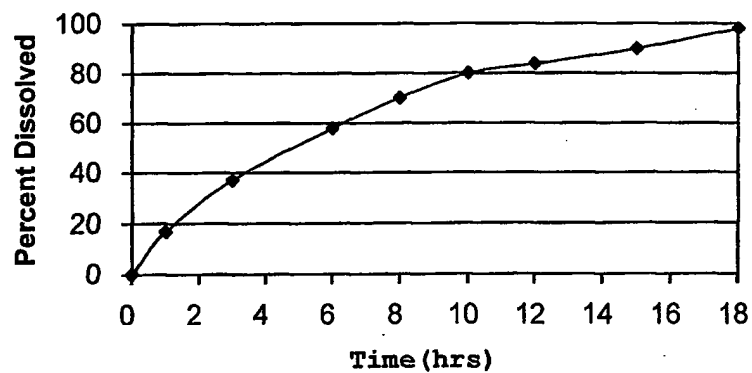
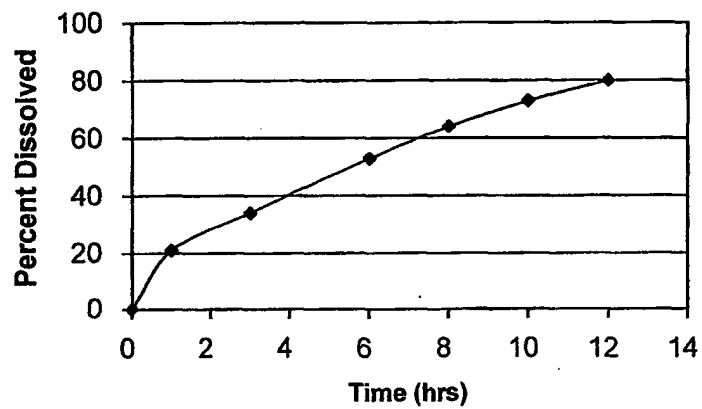


FIG. 2

**Dissolution Profile for 1 mg tablet of Alprazolam**



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FIG. 3

Dissolution Profile for 3 mg tablet of Alprazolam

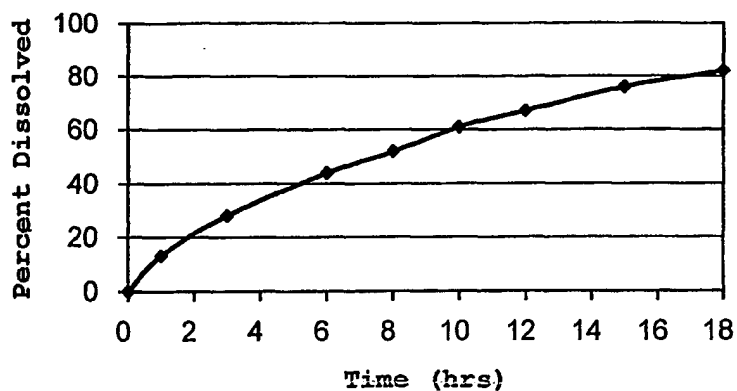
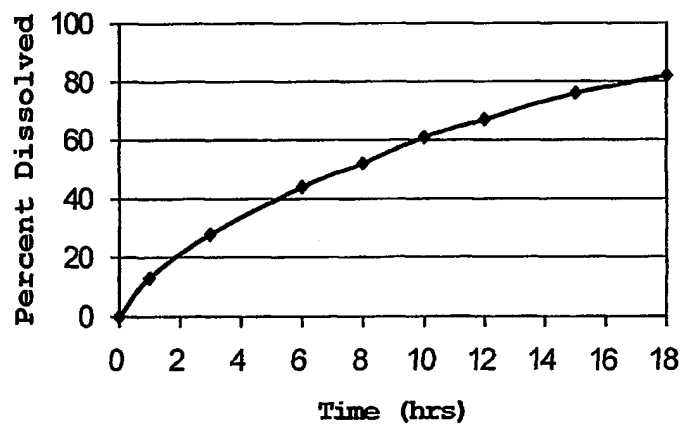


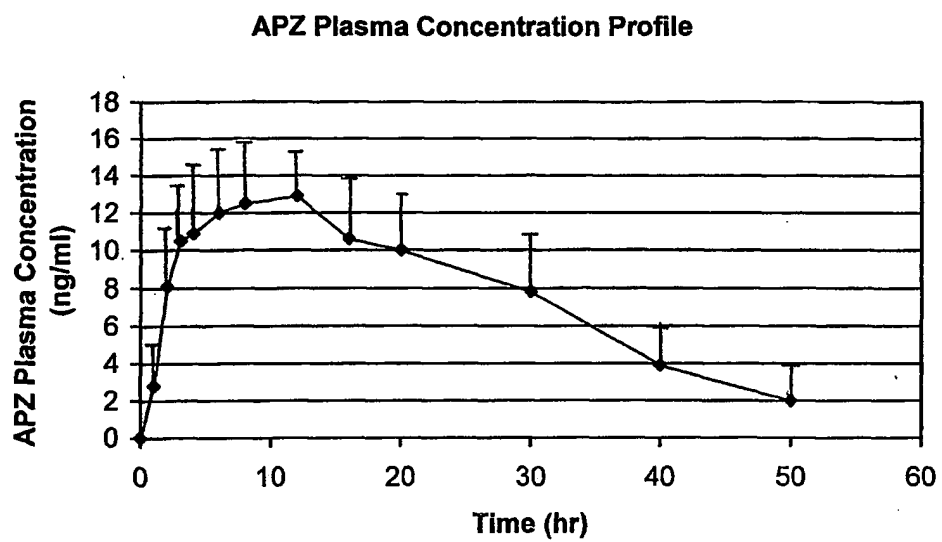
FIG.4

Dissolution Profile for 3 mg tablet of Alprazolam



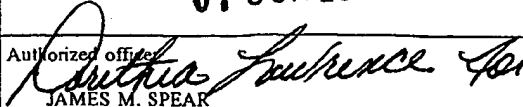
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FIG. 5



## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US01/00637

<b>A. CLASSIFICATION OF SUBJECT MATTER</b> IPC(7) : A61K 9/22, 9/24, 9/32, 9/36 US CL : 424/468, 472, 473, 474, 476, 475, 479, 482 According to International Patent Classification (IPC) or to both national classification and IPC														
<b>B. FIELDS SEARCHED</b> Minimum documentation searched (classification system followed by classification symbols) U.S. : 424/468, 472, 473, 474, 476, 475, 479, 482 Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)														
<b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b>														
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.												
A	US 4,968,507 A (ZENTNER et al) 06 November 1990, see column 13, lines 43-50, claims 1-17.	1-18												
Y	US 6,004,582 A (FAOUR et al) 21 December 1999, see column 15, lines 1-4, claims 1-8.	1-18												
<input type="checkbox"/> Further documents are listed in the continuation of Box C. <input type="checkbox"/> See patent family annex.														
<table border="0"> <tr> <td>* Special categories of cited documents:</td> <td>*T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</td> </tr> <tr> <td>*A* document defining the general state of the art which is not considered to be of particular relevance</td> <td>*X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone</td> </tr> <tr> <td>*E* earlier document published on or after the international filing date</td> <td>*Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art</td> </tr> <tr> <td>*L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</td> <td>*A* document member of the same patent family</td> </tr> <tr> <td>*U* document referring to an oral disclosure, use, exhibition or other means</td> <td></td> </tr> <tr> <td>*P* document published prior to the international filing date but later than the priority date claimed</td> <td></td> </tr> </table>			* Special categories of cited documents:	*T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention	*A* document defining the general state of the art which is not considered to be of particular relevance	*X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone	*E* earlier document published on or after the international filing date	*Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art	*L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	*A* document member of the same patent family	*U* document referring to an oral disclosure, use, exhibition or other means		*P* document published prior to the international filing date but later than the priority date claimed	
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Date of the actual completion of the international search 26 MARCH 2001		Date of mailing of the international search report <b>07 JUN 2001</b>												
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230		Authorized official  JAMES M. SPEAR Telephone No. (703) 308-1235												